Patent claims

1. Handheld working tool, having
- a first unit (1) excited by a vibration during operation,
- a second unit (2) that is capable of being moved at least in a working direction (A) relative to the first unit (1), and having
- a vibration isolation device (3) situated effectively between the first unit (1) and the second unit (2),
the vibration isolating device (3) having at least one actuator (4) for producing an actuating force with which an operating force acting in the working direction (A) between the first unit (1) and the second unit (2) is able to be at least partly compensated, and the actuator (4) being pneumatically operated,
characterized in that
- the actuator (4) has a handle air spring (11) whose filling with compressed air is able to be modified, and in that
- a spring device (5) is situated parallel to the actuator (4), between the first unit (1) and the second unit (2).

2. Handheld working tool, having
- a first unit (1) excited by a vibration during operation,
- a second unit (2) that is capable of being moved at least in a working direction (A) relative to the first unit (1), and having
- a vibration isolation device (3) situated effectively between the first unit (1) and the second unit (2),
the vibration isolating device (3) having at least one actuator (4) for producing an actuating force with which an operating force acting in the working direction (A) between the first unit (1) and

the second unit (2) is able to be at least partly compensated, and the actuator (4) being pneumatically operated,

characterized in that

- the actuator (4) has a handle air spring (11) whose filling with compressed air is able to be modified, and in that
- the vibration isolation is effected predominantly by the handle air spring (11).

3. Working tool according to Claim 1 or 2, **characterized in that**

- the working tool is a drilling and/or impact hammer,
- the second unit (2) has a handle (9),
- in the first unit (1) there is provided a pneumatic spring hammer mechanism having a drive piston (7) driven by a motor for driving an impact piston by means of an air spring (8) that is able to be produced between the drive piston (7) and the impact piston, and in that
- the drive piston (7) is fashioned for the production of compressed air for supplying the actuator (4).

4. Working tool according to Claim 3, **characterized in that** the actuator (4) has a compressed air storage device (10) that is able to be filled with compressed air by the drive piston (7).

5. Working tool according to Claim 4, **characterized in that**

- the actuator (4) has the compressed air storage device (10), a valve device (13, 14; 22, 23), the handle air spring (11), and a handle piston (12),
- the compressed air storage device (10) is able to be connected to the handle air spring (11) via the valve device (13, 14; 22, 23), and in that
- the handle air spring (11) acts on the handle piston (12) that is connected to the handle (9).

6. Working tool according to Claim 5, **characterized in that** the valve device (13, 14; 22, 23) is

fashioned such that when the handle piston (12) reduces a volume enclosing the handle air spring (11) beyond a predetermined value, compressed air is able to be supplied to the handle air spring (11) from the compressed air storage device (10) in order to restore the predetermined value for the volume of the handle air spring (11).

7. Working tool according to Claim 5 or 6, **characterized in that** the valve device has an outlet valve (14) for letting compressed air out of the handle air spring (11) when the volume of the handle air spring (11) exceeds a predetermined maximum value due to a displacement of the handle piston (12).

8. Working tool according to one of Claims 1 to 7, **characterized in that** a sensor (24) is provided for determining the relative position of the first unit (1) and the second unit (2).

9. Working tool according to Claim 8, **characterized in that**
- the sensor (24) and the valve device (22, 23) are connected to a control unit, and in that
- the valve device (22, 23) is able to be controlled by the control unit in such a way that in the handle air spring (11) a compressed air state prevails such that the relative positions (1) **[sic]**, acquired by the sensor (24), of the first unit and the second unit (2) are kept in a predetermined range of fluctuation.

10. Working tool according to one of Claims 1 to 9, **characterized in that** the spring device (5) has a softer spring characteristic than the actuator (4).

11. Working tool according to one of Claims 1 to 9, **characterized in that** the spring device (5) has a spring rigidity that is at least great enough that the spring device (5) is able to absorb the movement of an amplitude of the vibration without a bottoming out of the spring device.

12. Working tool according to one of Claims 2 to 11, **characterized in that** the actuating force produced by the actuator (4) is able to be modified cyclically, the modification taking place with the same frequency with which the drive piston (7) moves.

13. Working tool according to one of Claims 1 to 11, **characterized in that** a maximum actuating frequency of the actuator (4) is smaller than a frequency of the vibration produced in the first unit (1).

14. Working tool according to Claim 1 or according to one of Claims 5 to 13, but not dependent on Claims 3 or 4, **characterized in that** an air pressure-producing device, driven by a motor of the working tool, is provided in order to produce compressed air for the actuator (4).

15. Working tool according to one of Claims 1 to 14, **characterized in that** the actuating force of the actuator (4) is able to be set in such a way that a fluctuation range is ensured for the relative positions, caused by different operating forces, between the first unit (1) and the second unit (2) that is smaller than a fluctuation range that the relative positions between the first unit (1) and the second unit (2) would achieve given operating forces differing in the same way but without the compensating effect of the actuating force of the actuator (4).

16. Device for vibration isolation of a handle in a working tool, having
- a vibration exciter (31) in the working tool,
- a grip device (32) that is able to be moved relative to the vibration exciter (31) at least along a main direction (A), and having
- a vibration decoupling device acting between the vibration exciter (31) and the grip device (32), having a spring device (37) via which at least a part of the forces acting between the grip device (32) and the vibration exciter (31) is transmitted,

characterized in that

- the spring device has an air spring (37) acting between the grip device (32) and the vibration exciter (31), and in that
- the vibration decoupling device has a spring regulating device (34, 47) for changing the spring rigidity and/or the initial tension of the spring device (37) dependent on a force acting in the main direction (A) between the grip device (32) and the vibration exciter (31), or dependent on a relative position, corresponding to the acting force, of the grip device (32) relative to the vibration exciter (31).

17. Device for vibration isolation of a handle in a working tool, having
- a vibration exciter (31) in the working tool,
- a grip device (32) that is able to be moved relative to the vibration exciter (31) at least along a main direction (A), and having
- a vibration decoupling device, acting between the vibration exciter (31) and the grip device (32), having a spring device (37) via which at least a part of the forces acting between the grip device (32) and the vibration exciter (31) is transmitted,
characterized in that
- the spring device has an air spring (37) acting between the grip device (32) and the vibration exciter (31),
- the vibration isolation is effected predominantly by the air spring (37), and in that
- the vibration decoupling device has a spring regulating device (34, 47) for modifying the spring rigidity and/or the initial tension of the spring device (37) dependent on a force acting in the main direction (A) between the grip device (32) and the vibration exciter (31), or dependent on a relative position, corresponding to the acting force, of the grip device (32) to the vibration exciter (31).

18. Device according to one of Claims 16 or 17, **characterized in that** the force acting between the grip device (32) and the vibration exciter (31) is essentially a holding force exerted by an

operator on the grip device (32) in the main direction (A).

19. Device according to one of Claims 16 to 18, **characterized in that** the position of the grip device (32) relative to the vibration exciter (31) is held in a predetermined operating range by the spring regulating device (34, 47) in interaction with the acting force.

20. Device according to Claim 19, **characterized in that** the spring device (37) is able to be controlled by the spring regulating device (34, 47) in such a way that even given a changing force between the grip device (32) and the vibration exciter (31), the grip device (32) is held essentially in a target position, corresponding to a predetermined relative position, in the operating range.

21. Device according to Claim 20, **characterized in that** the target position is a center position in the operating range, and in that the grip device (32) is able to be moved from the center position to respective end positions over essentially equally long movement paths.

22. Device according to one of Claims 16 to 21, **characterized in that** the spring device (37) is able to be controlled by the spring regulating device (34, 47) in such a way that in a no-load operating state, in which the force acting between the grip device (32) and the vibration exciter (31) is below a predetermined boundary value, the spring device (37) has an increased rigidity.

23. Device according to one of Claims 16 to 22, **characterized in that** in an operating state in which the force acting between the grip device (32) and the vibration exciter (31) is above a predetermined boundary value, the rigidity of the spring device (37) is able to be reduced by the spring regulating device (34, 47) in such a way that the grip device (32) is in the target position of the operating range.

24. Device according to one of Claims 16 to 23, **characterized in that** the air for the air spring

(37) is provided by an air pump (43).

25. Device according to Claim 24, **characterized in that** the air pump (43) is operated by a drive motor of the working tool.

26. Device according to Claim 24 or 25, **characterized in that** the air pump (43) is operated by the oscillating relative movement between the grip device (32) and the vibration exciter (31).

27. Device according to one of Claims 24 to 26, **characterized in that**
- the air pump (43) has a pump chamber (42), provided between the grip device (32) and the vibration exciter (31), whose volume constantly changes as a result of the oscillating relative movement,
- via a first check valve (44), air is able to flow from the surrounding environment into the pump chamber (42) when the volume of the pump chamber (42) becomes larger, and in that
- via a second check valve (45), the air is able to be conveyed from the pump chamber (42) into an air spring chamber (36), in which the air spring (37) is formed, when the volume of the pump chamber (42) becomes smaller.

28. Device according to one of Claims 24 to 27, **characterized in that** the air supply flow from the air pump (43) to the air spring (37), averaged over a particular period of time, is essentially constant, and in that the spring regulating device has a valve device (34, 47) through which the exhaust air flow from the air spring (37) is able to be regulated dependent on the relative position of the grip device (32).

29. Device according to Claim 28, **characterized in that** the valve device has a valve opening (47) that is able to be opened when the grip device (32) moves further away from the vibration exciter (31), and that is able to be at least partly closed when the grip device (32) is brought

closer to the vibration exciter (31) in the main direction (A) under the action of the force, in particular when the grip device (32) is brought closer to the vibration exciter (31) than the center position of the operating range.

30. Device according to one of Claims 16 to 29, **characterized in that**
- the air spring (37) is formed in an air spring chamber (36),
- the valve opening (47) is provided in a wall of the air spring chamber (36),
- the valve device has a slide (34) that is able to be moved relative to the valve opening (47),
- the valve opening (47) is able to be moved either with the grip device (32) or with the vibration exciter (31), and, conversely, the slide (34) is able to be moved with the vibration exciter (31) or with the grip device (32),
- the valve opening (47) is not covered by the slide (34) when the grip device (32) is moved further away from the vibration exciter (31) than the target position, and in that
- the valve opening (47) is covered by the slide (34) when the grip device (32) is moved closer to the vibration exciter (31) than the target position.

31. Device according to one of Claims 16 to 27, **characterized in that** the spring regulating device has a valve device through which the air supply stream to the air spring (37) is able to be regulated dependent on the relative position of the grip device, and in that the exhaust air stream from the air spring (37) is essentially constant.

32. Device according to one of Claims 16 to 31, **characterized in that** the grip device (32) has at least one handle (33).

33. Device according to one of Claims 16 to 32, **characterized in that** between the grip device (32) and the vibration exciter (31) an elastic stop (39) is provided such that at least a part of the force acting between the grip device (32) and the vibration exciter (31) is transmitted via the stop

(39) if the spring rigidity of the spring device (37) is not sufficient to transmit the entire force.

34. Device according to one of Claims 16 to 33, **characterized in that** the spring device has an air spring (37), and in that the air for the air spring (37) is able to be supplied from an air storage device.

35. Device according to Claim 34, **characterized in that** air let out of the air spring (37) is able to be fed back into the air storage device.

36. Working tool according to one of Claims 1 to 15, having a device for vibration isolation according to one of Claims 16 to 35.